DRIFT SCALE TEST CONSTANT MASS FLUX AIR-PERMEABILITY TESTING IN HYDROLOGY BOREHOLES

PROCEDURE ID: YMP-LBNL-TIP/TT-1.0 | REV. 1, MOD. 0 | EFFECTIVE: 03/17/2000

1. PURPOSE

This Technical Implementing Procedure (TIP) describes the methods of air-permeability testing in the Drift Scale Test (DST) for the Yucca Mountain Site Characterization Project (YMP) at Ernest Orlando Lawrence Berkeley National Laboratory (LBNL).

The objective of air-permeability testing in the DST area is to monitor changes in permeability over time as thermal testing is being conducted. To assure the accuracy, validity, and applicability of the method used to collect routine constant mass flux air-permeability test data in the area, this procedure provides directions for performing the described activity.

This procedure describes the components of the work. It also describes the methods to be used for calibration, operation, and performance verification of any equipment, if needed. In addition, it defines the requirements for data acceptance, documentation, and control.

2. SCOPE

This procedure applies to all LBNL personnel or contractor personnel following LBNL procedures who conduct constant flux air-permeability testing in the DST Hydrology Boreholes. This activity is subject to the Quality Assurance Requirements and Description (QARD), DOE/RW-0333P.

For all technical activities, data collected using this procedure and any equipment calibrations or recalibrations that may be required shall be in accordance with this TIP and in full compliance with YMP Administrative Procedure (YAP)-12.3Q, *Control of Measuring and Test Equipment and Calibration Standards.* Electronic data maintenance, controls and transfers shall comply with YMP-LBNL-Quality Implementing Procedure (QIP)-SV.0, *Control of the Electronic Management of Data*

This procedure is designed to provide detailed methodology to assure consistent conduct of constant mass flux air-permeability tests. There may arise specific occasions for performing air-permeability tests which are not constant mass flux and hence this TIP will not apply. An example of such specialized air-permeability tests is constant pressure air-permeability tests or withdrawal air-permeability testing. Documentation of such testing shall be recorded in scientific notebooks as described in the Office of Civilian Radioactive Waste Management (OCRWM) Administrative Procedure (AP)-SIII.1Q, *Scientific*

Notebooks. If this testing becomes standard process, a TIP shall be prepared.

If this procedure cannot be implemented as written, YMP-LBNL personnel shall notify the responsible Principal Investigator (PI) or designee. If it is determined that a portion of the work cannot be accomplished as described in this TIP, or would produce undesirable results, that portion of the work shall be stopped and not resumed until this procedure is modified per YMP-LBNL-QIP-5.2, *Preparing Development Plans & Quality /Technical Implementing Procedures*.

If the responsible PI or designee determines that a modification or a revision to the TIP would cause an unreasonable delay in proceeding with the task, then an expedited change to the procedure, including documentation of deviation from the approved procedure, can be made according to YMP-LBNL-QIP-5.2. Such changes are subject to review, usually after the task has proceeded, and thus work performed under TIPs with expedited changes is done at risk of future invalidation.

Employees may use a controlled electronic or hard copy of this procedure; however, employees are responsible for assuring that the correct revision of this procedure is used. When this procedure becomes obsolete or superseded, it shall be destroyed or marked “superseded” to ensure that this document is not used to perform work.

3. PROCEDURE

The hydrology boreholes consist of twelve boreholes in the DST area commonly referred to as Boreholes 57 to 61, 74 to 78, and 185 and 186. Each borehole has zones that are isolated using pneumatic packers. Zone 1 is closest to the collar of the borehole, with the zone number ascending toward the bottom of the boreholes.

3.1 System Components

The air-permeability testing uses a Gas Flow Control System and a Data Acquisition System. The gas flow control system consists of all pneumatic plumbing, solenoid valves, mass flow controllers, etc. that are used to regulate and control the injection of air. The data acquisition system consists of all sensors, acquisition hardware, software, and wiring that interfaces to the gas flow control system.

3.1.1 Data Acquisition System

The data acquisition system is composed of two Keithley 2001 7 1/2 digit multimeters, a Keithley 7002 scanner system, a Windows NT

Personal Computer with monitor, and two Hewlett-Packard E3631A programmable power supplies. There is a GPIB IEEE488.2 compliant interface card installed in the personal computer, which interfaces the computer to the aforementioned electronics. The personal computer is running Labview data collection software, and uses three executable codes, referred to as virtual instruments (vi) for data collection. Software to operate the data acquisition system is specified in the scientific notebook and controlled in accordance with AP-SI.1Q, Software Management. Electronic management of data shall be controlled in accordance with YMP-LBNL-QIP-SV.

3.1.2 Gas Flow Control System

Air supplied through the tunnel compressed air system is first filtered, dehumidified using a regenerative twin-tower desiccator, and filtered again before being sent through mass flow controllers (MFCs). Attachment 1 is a piping diagram for the injection gas flow control system. Four Sierra Instruments MFCs, with full flow ranges of 1 Standard Liter Per Minute (SLPM), 10 SLPM, 100 SLPM, and 500 SLPM, which are connected in parallel, are selectively used to control the precise amount of gas being introduced into a borehole interval. The outlet of each MFC has a pneumatically controlled valve to ensure positive shut off when the MFC is not in use. Downstream of the MFC manifold is an array selection manifold. The array selection manifold directs the gas flow to one of the three arrays of hydrology boreholes, Boreholes 57 to 61, Boreholes 74 to 78, and Boreholes 185 and 186. Located near the collars of each borehole is another manifold, which directs the gas flow to the isolated zones within the borehole. A tracer gas injection system, as shown in Attachment 1 is connected to the gas flow control system, but is not used during air-permeability testing. Verify before conducting air-permeability tests, that tracer gas cylinders are closed at the compressed gas cylinder.

3.2 Test Preparation

Staff members preparing for air-permeability testing shall perform the actions described below.

3.2.1 Electronics

A. Before turning on the electronics for testing, turn on the air conditioner on the Electronic Rack and verify that it is properly cooling the rack. The air conditioner should maintain the rack at a temperature, which will fluctuate between 70°F and 95°F.

B. Turn on the Keithley electronics, the Hewlett-Packard power supplies, and the ±15V power supply used for the MFCs, which are all located in the electronic enclosure. Then proceed to turn on the computer monitor and finally the computer.

C. Verify that supply to the Setra transducers, which is located in the Acoustic Emission Electronic Enclosure in the main data acquisition office is turned on and set to 24 volts.

3.2.2 Gas Flow Control System

A. Check all manually operated valves located on the injection lines visually to verify that they are in the open position.

B. Turn on the twin-tower desiccant dryer, open the mine air supply valve and set the regulator on the output of the desiccant dryer to 60 PSIG.

B. Verify that the two manually operated 1/8" air supply line valves, located near the pressure regulator are open.

D. The inlet and outlet filters on the twin-tower dryer have visual gauges, which indicate the status of the filters. If at any time the indicator appears red, replace the filters at the next convenient time. It is not necessary to interrupt ongoing tests to change a filter. This is anticipated to be a once a year or less frequent maintenance item.

3.3 Calibration Requirements

3.3.1 Calibration Interval

The MFCs and Digital Multimeters are on a yearly calibration cycle. Verify that their calibration is still valid before collecting data. If they are not within current calibration or the data they are generating are suspect, they shall be removed from service and replaced with calibrated units. The units requiring calibration shall be calibrated by a qualified supplier in accordance with the requirements of YAP-12.3Q. Copies of the calibration reports shall

be provided to the M&TE Coordinator to update the M&TE list as per YAP-12.3Q.

3.3.2 System Component Accuracy

The accuracy of the MFC in the field is typically less than the published manufacturer's specifications. Although Sierra Instruments

MFCs are calibrated to their manufactured specification of ±1% of full scale, their required performance in the field for compliance with this TIP is ±10%. The Setra pressure transducers have a calibrated accuracy of ±0.1%, but under this TIP they are expected to provide data with a sufficient accuracy of ±0.25%.

3.2.3 Control of Out-of-calibration Conditions

If any out-of-calibration conditions (as described in YAP-12.3Q) are determined to exist for any Measuring and Test Equipment (M&TE) item used during a sequence of tests (i.e., calibration due date or interval has passed, equipment produces results known to be in error, software or programmable hardware for the M&TE has been upgraded and dictates recalibration, or M&TE that has not been calibrated has been used to collect data or gauge performance) the equipment shall have an out-of-service tag applied indicating that it is not to be used and, when possible, the equipment shall be moved to a segregated "out-of-service" area.

The above conditions shall be documented by using the M&TE Out of Calibration Report in accordance with the instructions provided in YAP-12.3Q. If it is determined that the data is impacted, a Nonconformance Report (NCR) shall be initiated in accordance with YAP-15.1Q.

3.4 Data Collection

3.4.1 Executing automated software performs data collection in the hydrology boreholes. Data file names are automatically selected, and include the date and time of testing to make them unique and distinguishable. They are saved onto the hard drive of the data acquisition PC. Testing has shown that a background data collection time of 2 minutes, with an injection time of 60 minutes and a recovery time of 60 minutes is satisfactory for obtaining a good data set, with most pressure transients reaching the desired pseudo-steady state. Pseudo-steady state is defined as when the pressure response curve shows only a very gradual change over time, which may be due to secondary influences such as barometric drift or redistribution of moisture. It shall also be noted that due to the two-phase and non-isothermal conditions within the DST area, it is not possible or practical to conduct each test until it reaches true steady state conditions.

3.4.2 Notebook Records

Staff members shall record the following information in their scientific notebook used for testing in accordance with QIP SIII.0 *Scientific Investigation*, and include:

A. Personnel present

B. Time when each vi was started.

C. Any unusual occurrences, equipment malfunction or testing interferences from activities in other boreholes.

D. Results of data review as conducted under section 4.1.

E. Reference to this TIP by number, revision and modification.

F. Name and version of software utilized to operate the data collection system.

G. Time at which and method used to ensure the completeness and accuracy of the data has been established and the method by which the security of the data is maintained.

H. Verification of backup of data.

The data generated from air-permeability testing are stored on the hard disk of the data acquisition system PC. The data shall be backed up after data collection has concluded and the backup shall be verified by comparing the sizes of the original and duplicate data files and by opening and visually spot checking a few copied data points. The verification shall be documented including the method of verification in the scientific notebook. The data generated by following this procedure shall be turned over to the Technical Data Coordinator in accordance with AP-SIII.3Q, *Submittal and Incorporation of Data to the Technical Data Management System,* for submittal to the YMP Technical Database (TDMS).

The data shall be reviewed before submittal to verify that the flow rates during testing were constant and that the pressure transients have been properly recorded. Any variation outside of expected equipment accuracy and repeatability shall be investigated and the data shall be evaluated as to whether they are to be considered acceptable and qualified. The impact of any unusual occurrences, equipment malfunctions or testing interferences as noted under section 3.4.2.C and 3.4.2.D shall be evaluated before submittal of data to the TDMS. These evaluations shall be documented in the scientific

notebook.

4. RECORDS

4.1 Lifetime

Records generated as a result of this TIP are entries in:

- Scientific notebooks or attachments to such notebooks and associated data
- Equipment Logbooks
- MT&E Out of Calibration Reports, if applicable.

4.2 Non-Permanent

None

4.3 Controlled Documents

Technical Implementing Procedure

4.4 Records Center Documents

Records associated with this procedure shall be submitted to Records Coordinator for transmittal to the Record Processing Center (RPC) in accordance with AP-17.1Q, *Record Source Responsibility for Inclusionary Records*.

5. RESPONSIBILITIES

5.1 Staff Members involved in this activity are responsible for following this procedure and turning over related documentation to the Records Coordinator for submittal to the RPC in accordance with AP-17.1Q. Related data shall be turned over to the Technical Data Coordinator for submittal to the YMP Technical Data Management System (TDMS) in accordance with AP-SIII.3Q.

Special qualifications and/or training unique to the conduct of this procedure are as follows: In the acquisition phase of the project, field supervisors and/or managers (or their designates) shall have a working knowledge of mechanical and electronic equipment. Field personnel shall have all safety training as required by LBNL Environmental Health and Safety regulations to operate basic electrical and low pressure compressed

gas systems, as well as to be in compliance with ESF General Underground Safety Training requirements.

5. ACRONYMS AND DEFINITIONS

6.1 Acronyms

AP	OCRWM Administrative Procedure
DST	Drift Scale Test
ESF	Exploratory Studies Facility
LBNL	Lawrence Berkeley National Laboratory
MFC	Mass Flow Controller
M&TE	Measuring & Test Equipment
NCR	Nonconformance Report
PI	Principal Investigator
OCRWM	Office of Civilian Radioactive Waste Management
QARD	Quality Assurance Requirements and Description
RPC	Record Processing Center
PSIG	Pounds Per Square Inch, gage
QIP	LBNL Quality Implementing Procedure
SLPM	Standard Liter Per Minute
TDMS	Technical Data Management System
TIP	LBNL Technical Implementing Procedure
vi	Virtual Instruments
YAP	YMP Administrative Procedure
YMP	Yucca Mountain Project

6.2 Definitions

Calibration: Comparison of a measurement standard or instrument of known accuracy with another standard or instrument to detect, correlate, report, or eliminate by adjustment, any variation in the accuracy of the instrument or equipment being compared.

Staff Member: Any scientist, engineer, research or technical associate, technician, or student research assistant performing quality-affecting work for YMP-LBNL.

Technical Implementing Procedure: Each TIP describes YMP-LBNL technical tasks that (1) are repetitive, (2) are standardized, and (3) can return different results if deviation from the sequence of steps occur.

7. REFERENCE

AP-17.1Q, *Record Source Responsibility for Inclusionary Records*

AP-SI.1Q, *Software Management*

AP-SIII.1Q, *Scientific Notebooks*

AP-SIII.3Q, *Submittal and Incorporation of Data to the Technical Data Management System*

DOE/RW-0333P, *Quality Assurance Requirements and Description (QARD)*

YAP-12.3Q, *Control of Measuring and Test Equipment and Calibration Standards*

YMP-LBNL-QIP-5.2, *Preparing Development Plans & Quality/Technical Implementing Procedures*

YMP-LBNL-QIP-SV.0, *Control of the Electronic Management of Data*

8. ATTACHMENTS

Attachment 1 Gas Flow Control System

REVISION HISTORY

09/30/98 Revision 0, Modification 0:

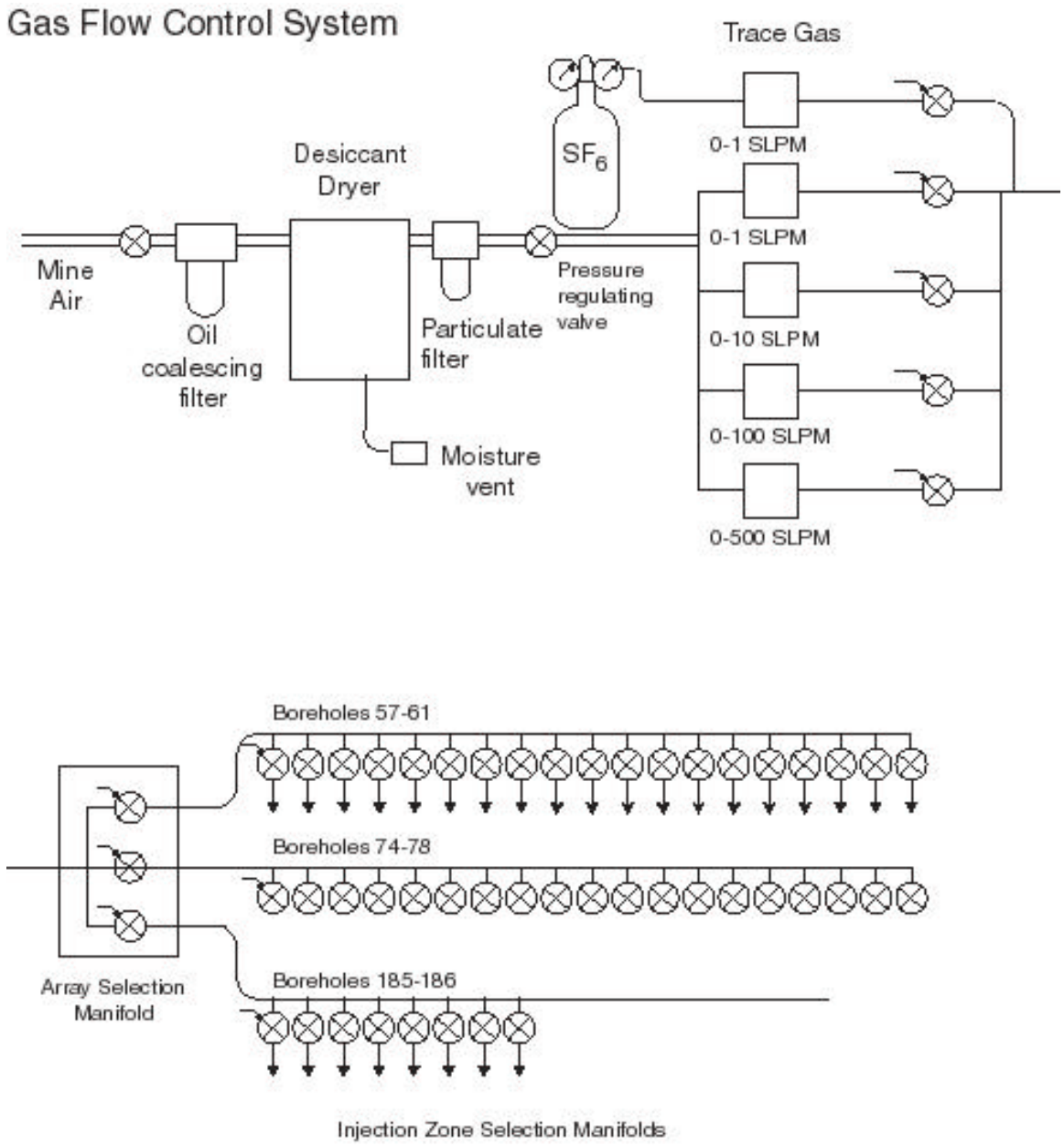
This is the initial issue of this procedure

03/17/2000 Revision 1, Modification 0:

Revised procedure to meet the YAP-12.3Q requirements, and incorporated references to other current APs, and QIPs. Deleted discussion on software and referenced AP-SI.1Q. Deleted responsibilities for staff members not directly responsible for implementing this procedure.

10. Approvals

Signature on file	
Preparer: Barry Freifeld	Date
Signature on file	
Technical Reviewer/PI: Yvonne Tsang	Date
Signature on file	
Technical Reviewer: Paul Cook	Date
Signature on file	
EA Reviewer: Nancy Aden-Gleason	Date
Signature on file	
OQA Concurrence: Stephen D. Harris	Date
Signature on file	
Project Manager: Gudmundur S. Bodvarsson	Date



Flow control system for Drift Scale Test constant mass flux air-permeability testing. Note: the SF_6 and trace gas MFC is not used for air-permeability testing.